varying degree store water in this manner, and at favorable points a portion of the water thus stored may be developed for irrigation by means of seepage ditches or by pumping plants. Seven hundred and fifty thousand acre-feet a year of available underflow in the Salt, Gila, Santa Cruz, San Pedro, Sulphur Spring and San Simon valleys is certainly a very conservative estimate of this supply. Even the little Rillito, according to the careful observations of Professor Smith, may be counted upon for enough water at a depth of less than fifty feet, to irrigate 8000 acres of land. The thorough utilization of small underflows as well as the larger areas will some day yield surprisingly large areas of cultivated lands, which we may roughly approximate at something like 200,000 acres.

SEEPAGE AND RETURN WATERS.

The initial application of irrigating waters, however, does not in most situations terminate its usefulness. A considerable percentage of the water applied to the soil escapes by percolation into the country drainage, whence in favorable situations it may be redeveloped and again applied. It is stated that in certain parts of southern California, where water is very valuable, decreasing increments of the original supply may be used as many as six times. In the fine soils and gentle gradients of the Colorado valley as little as ten percent of the original irrigating water may reappear as seepage. Along the Upper Gila as much as 64 percent of the original application has been recovered and again applied. The soil itself, therefore, constitutes a storage reservoir of immense capacity, receiving and gradually yielding up a steady volume of wa-

ter of great importance, especially to irrigators below the larger areas watered from natural stream flow or storage.

Summarizing our present and prospective water supply as derived from stream flow, storage and development by pumping, the following estimate of annual water resources for Arizona is tentatively submitted:

	Acre-feet.
The Colorado River, sufficient water to irrigate 350,000 acres of adjacent bottom and mesa lands	2,000,000
The Little Colorado and tributaries, with storage	300,000
The Salt River with storage	840,000
The Gila River without storage	160,000
Miscellaneous small streams and wells	143,000
Seepage or return waters, estimated at 10 to 30 percent of original river waters and not included in above estimates	200,000
Underflow in the larger river valleys of Arizona	750,000
Approximate total of both ascertained and estimated water supplies	4,393,000

At this time, therefore, estimating our privileges in the Colorado, conservatively reckoning on storage along the Salt and Little Colorado rivers, estimating seepage waters conservatively, and reckoning on a moderate development of underflow, the gross water supply reasonably within expectation in Arizona amounts to between four and five milion acre-feet annually. This amount of water, under average condi-

tions, economically applied, is sufficient to irrigate about one million acres of land.

SMALL WATER SUPPLIES.

Large supplies of cheap water, however, by no means exhaust our resources. When southern Arizona is developed comparably with southern California, water will for special purposes be pumped very much more than the fifty feet now considered for estimate-making purposes. Home surroundings may be profitably improved by small amounts of water pumped from deep wells. Under suitable conditions of tenure, stockmen can profitably develop deep water for use in connection with adjacent grazing ranges. In the frostless belts which lie high up on the sides of our warmer valleys citrus groves will be planted here, as in California, where water is pumped over 200 feet to irrigate oranges.

Small storage operations, also, have an important part to play in future utilization of water. Near the crests of our watersheds there are many small sites capable of retaining useful increments of water otherwise wasted on their way to lower levels. From ancient times the Papago Indians have availed themselves of such sites. During summer storms these primitive irrigators divert arroyo waters upon their crudely prepared fields, soaking the soil and starting their crops of corn, beans, squashes and melons. But to insure a crop they impound additional water by means an embankment across an adjacent swale, irrigating therefrom as necessary to bring their plantings to maturity. Following the lead of the Papagos the Mormon Colony on the east slope of the Sierritas

is growing successful crops of beans, corn, etc., on summer rainfall. There is in fact no reason why we should not here conserve and use our flood waters as successfully as did the Carthaginians of ancient times. It is related of this people that their slopes and hillsides were so embanked that the whole of their rainfall was collected in the apexes of downward pointing Vs in each of which was planted an olive or a vine. Concentrated in this manner a scant rainfall becomes several times effective and if supplemented by thorough cultivation and irrigation in times of unusual drought, will accomplish surprising results.

DRY-FARMING.

There are also considerable areas within the Territory where success by so-called dry-farming methods is fairly well assured. From the lower edge of the pines upward, with about twenty inches of rainfall, quick-growing summer crops of corn, oats, potatoes, fruits and vegetables may be grown by the ordinary methods of farming employed in more easterly states. At lesser elevations, by careful attention to details of moisture accumulation, drought-resistant crops and cultivation, there is still a possibility of remunerative returns. At still lower elevations where aridity is extreme irrigation wholly or in part will doubtless always be found essential except during those occasional unforseeable years when, as in 1905, winter crops could have been grown anywhere.

GRAZING.

Again, the grazing of sheep and cattle upon otherwise unoccupied lands must always be the basis of an important agricultural industry. Proper administra-

tion of these lands, not only within the forest reserves, but also in grass country, will considerably increase their productiveness, so that the present population of our ranges, estimated at some 1,000,000 sheep and 650,000 cattle alone, may be counted upon under an enlightened management of public lands, as an increasing and not a disappearing resource.

Finally, our forests, which may properly be considered a product of the soil, will under the conserving administration of the Forest Service, remain a never failing source of timber and of income to a considerable number of people. Our forests, fortunately, remain comparatively untouched, so that originally forested areas will in large part remain to benefit our people for an indefinite time. It is of interest to note in this connection that the income under Forest Service management from the forests of Arizona, was about $150,000 for the last fiscal year. With full development of forestry plans within our reserves this income will easily rise above a million dollars annually.

Summarizing now the material assets of agriculture in Arizona, we have: (1) A major water supply (partly ascertained and partly estimated) of between four and five million acre-feet of water, including storage and underflow, annually. This is sufficient to irrigate approximately 1,000,000 acres of land. (2) Small water development both by pumping and storage, of unknown possible extent. Such developments will specially lend themselves to the beautification of homes and the development of gardens and stock water supplies which will afford part or whole support to their owners. Water supplies of this character will become increasingly valuable especially in the vicinity

of towns and will ultimately support considerable populations. (3) Ordinary rainfall as utilized by dry-farming methods. Where supplemented by occasional flood waters and by pumped water, dry-farming methods will probably bring large but as yet unascertained areas under cultivation in eastern and northern Arizona. (4) Ordinary rainfall as expressed in grazing values over a vast extent of otherwise utilized country. (5) Ordinary rainfall as utilized by our forests.

The productive value to man of these several water supplies can only be approximated within very elastic lines, which however, may here be briefly suggested: On the basis of 200,000 acres of land now irrigated in Arizona, yielding about $9,000,000 worth of products it is fair to expect that under the more intensive conditions of the future, five times this amount of doubly productive soil will yield measurably within $90,000,000 worth of products. Small water supplies, developed by pumping and storage by individuals may possibly amount to ten percent of this major figure, or, say, $10,000,000 annually. Dry farming methods, either independently at high altitudes, or supplemented by irrigation at lower levels, may possibly at some time add another million acres of unintensive lands to our farmed area, contributing, we may say, another $10,000,000 to our output. The grazing industries, now yielding an annual income of about twelve million dollars may, under improved administrative conditions be expected to yield, let us say, $15,000,000. The lumber output under Forest Service regulations will add a small but important increment to these approximate totals, amounting, we will say, to a round $125,000,000 annually for the products of the soil.

This broad estimate is based on conditions as we now understand them and on the personality of our present population. With better knowledge of arid region farming practice, and with a people compelled to closer standards of living, such an estimate might be raised; for the personal factor is all important and is capable of giving us a latitude of outcome as wide as that between the modern wastes of Algeria and the populous, tree-clad slopes of ancient Carthage. Translating financial estimates into population we may say that since our present agricultural population of about 65,000 people produce, including livestock, values to the extent of about $15,000,000 annually, egiht times that income should support considerably over half a million people. Or, estimating that each two acres of irrigated land or its equivalent will, directly or indirectly, add one person to our population, we arrive at the same figure—a potential agricultural public for the Territory within the reasonably imaginable future of over half a million souls.

THE HUMAN ELEMENT.

But numbers mean less than character in any population and it is therefore principally interesting to us to consider the sources and characteristics of this growing element of our commonwealth, and certain of the developing social reactions within it. Diversity of individuals and consequent lack of class characteristics impress the observer. From the four corners of the earth—from Southern, Western, Northern and far Eastern sections of our own country; from Europe, Asia and the islands of the sea,—by chance, necessity or preference, a most diverse population has come to-

gether within our borders. Moreover, this population is not segregated, each element by itself, as in the separate quarters of a large city, but is thoroughly incorporated—a mixed and highly reactive society. The extent of the aggregate experience and knowledge of such a community must therefore be exceptional, combining the homely arts of antipodal peoples and the manner of thought of all ranks and conditions of men. Not only, however, are these people diverse in blood, disposition, manners and habits of thought, but with all this they find themselves in a unique situation—one in which their characteristics must be adapted, their usages reformed and their traditions cast aside.

This diversely minded people, this unformed society and this unsolved physical situation must be expected inevitably to develop highly original characters both in the population, and in its arts and institutions. Tommasso Bellini, from Italy, John Schmidt, of Germany, Colonel Williamson of Texas, and P. D. Quickly of Rhode Island, coming together through the medium of an irrigating ditch, the like of which none of them ever saw before, are bound to impart ideas to each other; and the physical and financial survivors of that meeting necessarily emerge in a reconstituted condition. With the pressure of increasing population in recent years, social readjustment has become more active, the demand for answers to urgent industrial questions more acute, and from the prevailing diversity and incongruity the outlines of certain dominant ideas of a new order have begun to appear.

Above all other ideas important, however, to the Southwestern farmer is that of industrial cooperation. Under the humid conditions of our Eastern

states the farmer is very much of an individual acting for himself with more or less success against all comers. But the very first necessary act of an irrigator on a large stream is to associate himself with others for the purpose of securing water. The fruits of many courageous but single-handed attempts by irrigators to establish themselves along the Colorado, especially, illustrate the necessity for association. While traveling down that river by small boat some years ago I must have passed the wrecks of twenty more or less ingenious devices for raising water to adjoining lands. Even small ditch companies have been unable to cope with this eccentric and unruly river; and only the highest type of cooperation through the medium of the Reclamation Service has proved adequate to the subjugation of this great irrigating river. Similarly on less difficult rivers, final success in irrigating has only been achieved through thorough cooperation. Even so individual a thing as an artesian well, drawing upon a common underground supply, involves a man with his neighbors practically and oftentimes legally. It is hard indeed to be alone in a land whose physical futures compel men into efficient union one with another.

In some instances, as along the Colorado river, the physical immensity of the engineering problem has compelled association in advance of development. Before even a few acres could be securely irrigated it has been found necessary to construct an immense barrage across the river, build levees, anticipate dainage and solve in advance the whole complicated plan of improvements for the region.

But in Salt River valley development has preceded

the most effective association. The character of this stream permitted small companies of farmers to develop water which was at first adequate to their needs. In time, however, as population and the need of water increased, and with the advent of dry years, this abundance failed and the people through crop losses, water litigations, and other hardships were finally driven into that splendid cooperation which has given them the magnificent Salt River irrigating project, including the Roosevelt storage reservoir.

In yet another class of cases the cooperation has been voluntary and founded on social motives from the beginning. The Mormon people, with irrigating experience in Utah behind them, have for the last thirty years been cooperating successfully as irrigators in many of our most fertile valleys. By reason of their religious organization and sympathies, and under excellent leadership, these people have uniformly succeeded in reclaiming desert lands wherever water was to be found. To this hardy, courageous, well-organized and ably-led element of its populatio the Territory is indebted for its best lessons in irrigation up to the present time. That we may understand the pioneering efficiency of these people I may relate an instance that came under recent observation. A man with his wife and children, all girls and the oldest 18, pushed over from the Upper Gila into Sulphur Spring Valey. They arrived with ten cents and a sack of flour, besides their team, wagon, plow, cow, chickens and a few cooking utensils. A little ground was broken and some sorghum, melons and squashes were planted before the summer rains fell. A load of picked-up wood hauled thirty miles to Bisbee renewed

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"OUR FARMERS AND OUR FUTURE"

ADDRESS DELIVERED IN THE COURSE OF LECTURES OFFERED TO THE PUBLIC BY THE DEPARTMENT OF ECONOMICS OF THE UNIVERSITY OF ARIZONA, OCT. 21, 1909

BY

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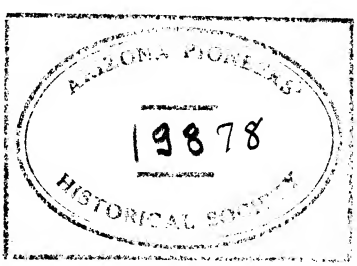
DIRECTOR OF THE AGRICULTURAL EXPERIMENT STATION



the provisions, which were supplemented by cottontail rabbits from the vicinity. Meanwhile the girls, barefooted, trod mud, made adobes and finally put up the walls of their house, which was covered with a roof likewise of clay. More wood to Bisbee kept them in provisions until their crops began to mature—sorghum for horses and cow; melons, squashes and vegetables for themselves. More ground was broken, sundry improvements were made and after three years this family lives in a comfortable house with a wide, cheery fireplace inside and with fenced fields, hay stacks and a few cattle and other evidences of prosperity nearby. To such men and women as these the commonwealth owes much of its present advancement. Their personal hardihood, their capacity for cooperation, and their docility under leadership have made them the natural inheritors of both water and land, and potent factors in the development of many of our institutions.

Cooperation must not stop, however, with water development only. By reason of our distance from markets, having produced a crop, it is almost equally necessary for our farmers to associate themselves for the purpose of marketing it. Such association combines small shipments to form large ones, makes advantageous dealings with other business organizations possible, enlists competent service where required and tends to put the farmer into business relations with his markets. Following the lead of California and Colorado in this particular, there now exists within the Territory an orange growers' association, five cantaloupe gowers' associations, two or three bee-keepers' associations and a hay-producers' association, besides

organizations of cattle and sheep men. Here again, by virtue of necessity, the trend among our farmers is more and more towards association and industrial brotherhood.

Another prominent tendency under our conditions is the development of a suburban type of country life in our irrigated valleys. Conditions here favor intensive farming. Large tracts are being broken up into small areas until it seems as if ultimately the typical farm will be simply a large back yard, and our valleys like straggling towns with houses wide apart. Such communities, with their inter-urban lines of travel, their good roads, rural delivery of mail and packages, and the numerous meetings between people necessitated by their canal, shipping and other organizations, will necessarily attain a degree of social development far beyond that of a country cut up into large farms and without the incentives to organization existing in an isolated irrigated region.

THE THINKING FARMER.

Again, under our intensive, irrigated conditions and with our usual extremes of climate, farming must ultimately develop into a high art. Nowhere are the factors of plant growth—soil, water, temperature and even illumination, so under control as here, making the handling of crops a matter almost of exact management. High capitalization of our limited areas of irrigated lands, also, will necessitate high-class farming for adequate returns. Through natural opportunity, therefore, and for consequent financial reasons, a skillful use of soil and water by an unusually intelli-

gent class of farmers will always be found necessary in the agricultural conduct of the region.

Taking both their material and their personal assets into consideration, therefore, the future of our farming public seems unusually interesting and hopeful. The diversity of our types of agriculture—irrigation, pumping, dry-farming, grazing and forestry; and the remarkable variety of crops, trees and animals which may be profitably produced in this sub-tropical country, insures that every inclination or bent of mind among our farmers may have its opportunity. There is no chance for that uniformity of mind among our people that must characterize regions of but one agricultural idea—wheat, potatoes, oranges, corn and hogs, or dairy products as the case may be. With all this diversity, however, our people are strongly bound together in interest through the medium of their water supply. The man who fells a pine tree on a remote mountain side commits an act vitally interesting to the irrigator hundreds of miles away, for his watershed is at stake. The stockman who runs a band of sheep or a bunch of cattle on our grassy plain, likewise effects the runoff on which the downstream irrigators depend. The builders of ditches and of storage reservoirs therefore have certain rights both moral and established, in the operations of their upstream neighbors. These latter in turn are interested in the success of those owners of irrigated fields who purchase and feed range stock on their more abundant forage supplies, and who return many of the necessities of life in exchange.

The Southwestern farmer indeed can little afford a narrow minded confinement within his own fence

lines. He must always in a spirit of fairness grasp his general agricultural situation in order that the whole interlinked industrial family that draws in various ways and places upon the supply from any watershed, may live in equity together. It seems reasonable in this connection that those broad principles of justice and of religion originating among the irrigating nations of the far East, may have naturally, to some extent, arisen in connection with the administration of their life-giving water supplies; for the influence of an irrigating stream is *social* and the mind of an irrigator necessarily considers and regards the rights of his fellowman. But between the compulsory association under despotic forms of government of ancient Eastern peoples, and the voluntary cooperation of the American irrigator, there is a vast difference. Self-assertive by race and in his personal bringing up, the Ameircan farmer-immigrant retains his initiative, thinks for himself, and chooses freely his own course of action. In his new and strange surroundings, indeed, independence from the rules and traditions of the home country and freedom of action in the new environment are essential to an early solution of the administrative and agricultural problems of this country.

As a commonwealth, therefore, and in particular respect to our farming public, we may consider ourselves peculiarly fortunate:

1. In the possession of water, range, and forest resources sufficient when developed to support a population of probably over half a million souls.

2. In an immigrant personnel which, coming from every state of the Union and most of the countries of

the world, brings with it an extraordinary assortment of experience and knowledge; and every phase of character and social training.

3. In that absence of precedent and tradition, which throws men upon their own resources, requires them to solve their own industrial and scientific problems, and to an unusual degree permits them originality of thought and action in the management of their own affairs.

4. In the possession of incentives to an industrial and social cooperation which, intelligently and equitably worked out, will give us a condition of the highest and happiest development in our rural society.

OUR FARMERS AND OUR FUTURE

In books of Southwestern travel of fifty years ago, serious and interesting observations abound as to the future of the region now partly comprised within the limits of Arizona. The hardships of the trapper, the prospector, the overland traveler and the soldier did not encourage a hopeful view; nor were the yarns of imaginative story-tellers reassuring in character. Even so long as sixty years ago, however, there were signs of those industries which are now growing with accelerating rapidity, and which bid fair ultimately to place Arizona well up in wealth and diversity of interests among the Rocky Mountain States. Copper and silver and a little gold were mined in the southern districts; a few cattle and sheep were precariously maintained in an Indian infested country; a little whipsawed lumber was brought down from the high mountains, and small scattered areas of land were irrigated to eke out the living of a sparse, mixed and shifting population. Perhaps the best farmers in Arizona fifty years ago were the Pimas and Papagos of the southern districts, and the Moquis of the far north. Along the Gila and Salt rivers, particularly, the agricultural Pimas have from ancient times skillfully irrigated their small farms, growing good crops of corn, beans, squashes, melons, wheat and other products. In the days of the Butterfield road and of the Argonauts the provisions thus made available greatly facilitated travel, and in fact made more readily possible

the early beginnings in mining, stock raising and transportation which later increased to large proportions.

Our farmers, even from prehistoric time, have thus developed useful varieties of plants and local knowledge of an art which from the beginning of Mexican and American occupation has maintained a chain of oases throughout an otherwise desert region; and which have served in turn as bases of supply for the conquistadors and the religious; for trappers and prospectors; for soldiers, filibusters and Indian war parties; for overland wagon trains and military columns, for stockmen and miners, and at last, for our own increasingly permanent population. From humble and obscure beginnings, therefore, farming and the farmer have gradually and in spite of the most unusual discouragements, increased in importance until they now stand in fair comparison with other industries.

As a matter of agricultural history, the actual magnitude of farming interests during the past sixty years can be fairly approximated from time to time. When the Gadsden Purchase was made, in 1854, there were probably not more than two thousand acres irrigated by the Mexican people, mostly along the Santa Cruz and San Pedro rivers. In addition there was an indefinite and fluctuating area farmed by Pimas, Papagos, Mojaves, Chemehuevis, Moquis, Navajos and Apaches in various parts of the Territory, amounting perhaps to five thousand acres more. Between five and ten thousand crudely farmed acres is probably a fair approximation for cultivated land in Arizona at that time. With the opening of Salt river valley in 1867 irrigated areas rapidly increased until in 1890,

according to the eleventh census, 65,821 acres were cultivated in Arizona; in 1899 by the twelfth census, 185,396 acres were being watered, while at this time about 228,000 acres are actually farmed. From 15,000 to over 200,000 acres in fifty-five years might seem like a fair rate of development, into the continuation of which we may at this time well inquire.

Any estimate of the future of farming in this region must rest mainly upon an estimate of the water supply available for irrigation. There is reasonable expectation that so-called dry-farming methods will in some parts of the Territory contribute to our crop output; and the growing industries will always afford substantial returns; but irrigation is and always will be the main factor in productions from the soil. At the present time, with over 228,000 acres under cultivation, the minimum stream flow of all our rivers except the Colorado is used, and only flood waters escape from the region. This is especially true of the Salt river, with 130,000 irrigated acres; of the Verde, the Gila, the Santa Cruz and many smaller streams which at times of low flow barely suffice to maintain the farming areas dependent upon them.

MATERIAL RESOURCES.

It is, therefore, evident that further development must depend (1) upon the storage of flood waters, (2) upon the development of underground supplies, (3) upon the more effective application of water in agricultural operations and (4) upon the direct utilization of rainfall.

RIVER FLOW AND FLOOD WATERS.

Fortunately for the purposes of estimation the flows of the principal streams of Arizona have now been measured for a sufficient time to give us a fair idea of the water available in this form for irrigation.

THE COLORADO.

By far the largest, though least developed source of supply is the Colorado. This greatest of arid-region streams drains, including the Salton Basin area, a watershed of about 300,000 square miles, lying between 31 degrees of latitude in Mexico, and 41 1-2 degrees in Wyoming; and rising from below sea level to an altitude in Colorado of over 14,000 feet. The rain and snowfall in this high portion of the watershed ranges from 8 to 30 inches of water; and the climate, because of increasing latitude and altitude, varies from subtropical to temperate and finally to arctic in character where mountain tops are clothed in perpetual snow. To the peculiarties of this watershed—its range in latitude and altitude, its topography, its soil cover, and its climate, is due the characteristic flow of the lower Colorado river. This is mainly distinguished by the annual flood which recurs with great regularity from approximately the fifteenth of April to about the fifteenth of July. This flood, which has given the Colorado the name of the Western Nile, results from the melting of snows on the upper watersheds, especially in Colorado, Wyoming and Utah. Due to this cause each spring thousands of mountain streams converge to form rivulets and then rivers, which are finally united to form the turbid volume of the great Colorado. Irregularities in volume of this flood, conse-

quent upon climatic variations, occur, and high water may also occur at other times of year. In general, however, after the subsidence of the summer flood the volume of flow sinks to comparatively small dimensions for the remaining nine months of the year. After this fashion the Colorado at Yuma has been known to vary from less than 3000 cubic feet per second to as high as 150,000 cubic feet in flow, delivering on an average about 12,000,000 acre-feet of water a year. It is evident that an arid region stream varying up to fifty times its minimum flow affords both incentive and opportunity for flood-water storage. Fortunately, the Colorado has some very capacious storage sites on its upper courses, the Brown's Park and Kremmling sites in Colorado and Utah alone aggregating a capacity of 4,200,000 acre-feet.

To be brief, the runoff and storage resources of the Colorado River are sufficient after satisfying upstream requirements in Colorado, Wyoming and Utah, to irrigate the whole of the fertile bottom lands along its lower courses, including accessible parts of the Salton Basin and the irrigable lands of the Mexican delta. This is a most fortunate fact, looking towards a confident and harmonious utilization of the water resources of this important stream.

The Federal character of the Reclamation Service, and the provisions of the Reclamation law, make possible a comprehensive and effective administration of the waters of this river, of which about 2,000,000 acre-feet annually will be required in Arizona. This greatest of our water resources can only be utilized by means of vast engineering projects rendered possible by government agency. The Colorado is too big

and too unruly to be profitably attempted by the individual irrigator or by any company of unskilled farmers. The highest and most powerful type of co-operation, possible only with the help of our Federal government, is necessary to the solution of the problems presented by this interesting and eccentric river.

SALT AND GILA SUPPLIES.

Next in importance as a flood water stream is the Salt River. The watershed of the Salt, including that of its main tributary, the Verde, has an area of 12,240 square miles lying in central and east-central Arizona, and ranging to upwards of 10,000 feet in elevation. The summer rainfall upon this watershed is largely torrential in character and ordinarily lost in floods down stream. The Gila River, like the Salt, is subject to extensive floods of even more sudden and destructive character due to the barer conditions of its originally grassy watershed. Both the Salt and Gila rivers, however, and certain of their tributaries, are fortunate in the possession of a number of extensive storage sites. The principal of these, some eight in number, have been surveyed to a practicable capacity of 2,971,000 acre-feet, sufficient with our mean average floods to make safe the irrigation of probably 300,000 acres of land additional to that already watered from the unregulated stream flow. The largest site in the Gila or Salt watersheds—that of the Roosevelt reservoir—will soon be in use, the dam now being almost complete. One million two hundred and eighty-four thousand acre-feet of storage capacity will by this one reservoir alone be rendered available for irrigation purposes.

The Little Colorado, likewise, possesses a number of fairly ample reservoir sites, which have been surveyed to a feasible capacity of about 410,000 acre-feet, sufficient, ordinarily, to store flood waters of the Little Colorado for the irrigation of about 100,000 acres of land. So far as reconnoitered, therefore, the larger storage sites on Arizona streams have a surveyed capacity of about three and a half million acre-feet of water. In some instances storage capacity exceeds the runoff within average expectation; in others even with all available storage occasional flood waters would still escape. With the construction of the feasible storage works now surveyed, however, it is safe to say that the areas now watered on the Salt, Gila and Little Colorado rivers would be doubled or, possibly, trebled.

UNDERGROUND STORAGE.

Ordinary reservoirs, however, are not the only means of water storage. Beneath our feet, in favorable locations, there is immense capacity for the retention of flood waters. Filled with the detritus of adjacent mountain ranges these ancient valleys may retain as high as from 30 to 40 percent of their volume of water in the interstices of their porous contents. Illustrating the possibilities of such a valley is the instance of the disastrous flood of 1903 at Clifton. This flood, thirty feet deep, after destroying the town, passed down the Gila but entirely disappeared before it reached the head of the Buckeye canal 180 miles below. In this instance an entire flood of water was absorbed into the underground storage of the Gila, excepting the minor portion that found its way into ditches or escaped by evaporation. All of our desert rivers in

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